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MOLECULES IN AN INFRARED CIRRUS CLOUD

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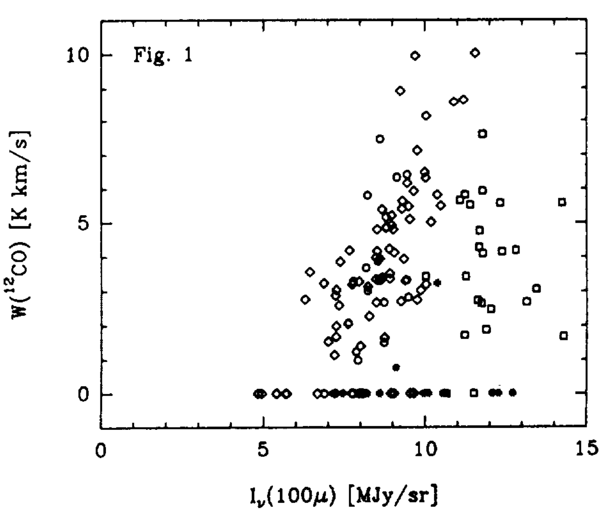
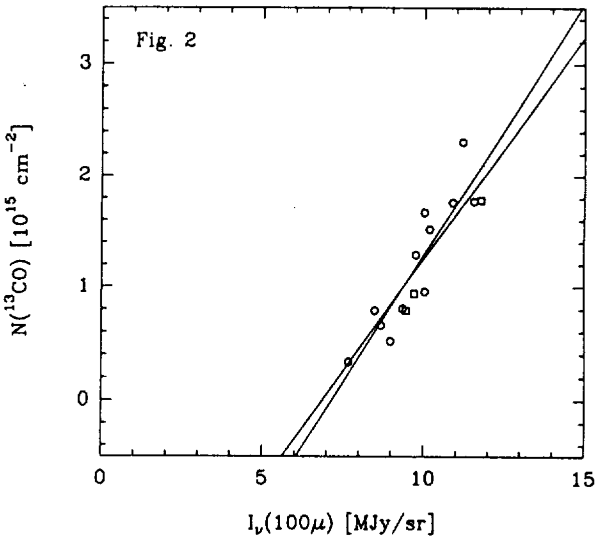
High latitude dark and bright nebulae were already catalogued by Lynds (1962, 1965) and re-detected in the 100 μm band of IRAS (Low et al. 1984). CO was detected in a number of high-latitude clouds (e.g. Goerigk et al. 1983, Magnani et al. 1985). A prominent feature at 100 μm is the Polar Loop (e.g. Wesselius and Fejes 1973, "Polar Ridge"). It is expanding at a velocity of 5 or 10 km/s (Heithausen and Meyerdierks 1987). One of the clouds that form the Polar Loop was observed in the $1_{10}-1_{11}$ 4.8 GHz transition of formaldehyde and in the J=1-0 transitions of ^{12}CO and ^{13}CO at 115 GHz and 110 GHz resp.

The cloud, which has an extent of 2.5° by 4°, consists of several filaments 1° or 2° long and 0.5° wide. From the correlation of IRAS 60 μm and 100 μm intensities we derive a colour temperature of the dust of 21 K and a maximum optical depth of $3 \cdot 10^{-4}$ (assuming $\tau \propto \nu^2$). At one local maximum of the 100 μm intensity, the hyperfine structure of formaldehyde could be resolved. While the H_2CO column density is $(4.4 \pm 2.0)\ 10^{13}$ cm^{-2}, the excitation temperature of 2.43 K implies a gas density of $(2 \pm 1) \cdot 10^5$ cm^{-3} for kinetic temperatures of 10 to 20 K according to Garrison et al. (1975). Maps of this region in H_2CO and CO show the size of the molecular clump to be 7'. LTE calculations for the observed CO isotopes (cf. Dickman 1978) result in a peak ^{13}CO column density of $(2.3 \pm 0.8) \cdot 10^{15}$ cm^{-2}. Converting this to H_2 column density (Dickman) and assuming a distance of 100 pc, the H_2 density should be 2000 cm^{-3}. Obviously the molecule distribution is very clumpy on a scale of less than 1 pc and the observations suffer from beam dilution (3' and 4.4' beams).



Since the infrared optical depth is small, the 100 μm intensity can be used as a measure of dust column density. Figure 1 compares this with the observed ^{12}CO line integral. Different



symbols denote different parts of the cloud. The 100 μm intensity jumps when moving from one part to the other but is roughly constant within each of these parts. On the other hand, the CO line integral varies within each part between 0 and 10 K·km/s. This behaviour seems to contradict the assumption that ^{12}CO is optically thick. Figure 1 can be understood as follows: The dust emission per nucleon is equal for dust related to HI or to H_2 (de Vries et al. 1987). Figure 1 then indicates that most of the proton column density is in HI. Only where dense clumps are on the line of sight (i.e. where ^{13}CO is detected), is the molecular column density comparable to the atomic one of the surrounding, less dense envelope. This is demonstrated by figure 2, which shows the correlation of ^{13}CO column density and 100 μm intensity. Roughly half of the dust column density seems to be related to non-molecular gas even at the peak molecular column density.

Finally, the stability of the molecular clump described above can be considered. At an assumed distance of 100 pc the H_2 mass would be 0.6 $M_\odot$, while the virial mass for a radius of 0.1 pc and a line width of 1.3 km/s would be 35 $M_\odot$. Thus the clump is anything but gravitationally bound and will probably disperse on a time scale of $6 \cdot 10^4$ years. Similarly, the filaments which would be 1 pc across would disperse in $3 \cdot 10^5$ years.

It remains to be seen, if this transient nature is a general property of cirrus clouds. The cloud investigated here may well be special because it belongs to an expanding loop. On the other hand, shocks moving through the interstellar medium may hold a key to the understanding of the filamentary morphology of the infrared cirrus.

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